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SPECIFICATION

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[Cushions with Non-Intersecting-Columnar Elastomeric Members Exhibiting Compression Instability]

Cross Reference to Related Applications

This patent application is a continuation-in-part patent application of serial no. 09/303,979 filed on May 3, 1999, now U.S. Patent No. _____, which is a continuation-in-part patent application of serial no. 08/968,750 filed on August 13, 1997, now U.S. Patent No. 6,026,527, which is a continuation-in-part patent application of serial no. 08/601,374 filed on February 14, 1996, now U.S. Patent No. 5,749,111 and which is a continuation in part of serial no. 08/783,413 filed on January 10, 1997, now U.S. Patent No. 5,994,450, which claims priority to U.S. provisional patent application serial no. 60/021,019 filed on July 1, 1996, and priority is claimed to each of the foregoing. Priority is also claimed to U.S. provisional patent application no. 60/226,726 filed on August 18, 2000.

Background of Invention

[0001] The invention relates to the field of cushioning, and in particular cushions made from soft elastomeric material, including gelatinous elastomers, and those cushions that operate according to a principle of compression instability.

[0002] Previously, the inventor made inventions concerning gelatinous elastomers ("gels") disclosed and claimed in U.S. Patent No. 5,994,450, which is hereby incorporated by reference. The inventor has also made inventions in the field of elastomeric cushions with intersecting or joined buckling columns, as disclosed and claimed in U.S. Patent Nos. 5,749,111 and 6,026,527, which are hereby incorporated by reference. These are referred to herein as cushions having intersecting-columnar members.

[0003] In cushions having intersecting-columnar members, column walls are shared between columns. When an irregularly-shaped object is placed on the buckling column cushion, the walls will buckle under areas of peak load, thereby relieving and

distributing cushioning pressure. The buckling occurs when maximum support pressure per the cushion design is exceeded in a particular area of the cushion. Buckling is accomplished by the column walls buckling or folding on themselves. Surrounding columns support the cushioned object even though buckling has occurred in an area of peak load. In this way, pressure is reasonably equalized without significant high pressure points.

[0004] Although intersecting-wall buckling columns are very efficient and useful and represent an significant advance in the science of cushioning, they are not totally without problems and challenges. One problem with cushions having intersecting-columnar members is manufacturability. When buckling column cushions having intersecting-columnar members are molded, the gel material from which they are made must flow into a mold and meet itself at each column intersection. There are a myriad of such intersections, one at every corner of every joined column. At these intersections, there is a knit line. Knit lines are at risk of having poor strength due to incomplete melding of opposing flows of flowing gel material.

[0005] A second problem with cushions having intersecting-columnar members is weight. Joinder of adjacent columns in buckling cushions having intersecting-columnar members adds to the stability of each individual column because they each can derive stability from adjoining columns. Thus, in order to achieve buckling at a low load level, buckling cushions having intersecting-columnar members must be relatively tall, high or deep. Increasing the size of the cushion in this dimension adds gel material and increases weight (and material expense).

[0006] A third problem with cushions having intersecting-columnar members relates to the manufacturing constraints concerning size. In making molds for an injection molding process, there are constraints on the minimum saw kerfs and minimum thicknesses of passageways within the mold to achieve acceptable gel flow.

[0007] A fourth problem with cushions having intersecting-columnar members is tooling cost. Molds and dies for making buckling cushions having intersecting-columnar members are complex and time consuming and costly to make.

[0008] The prior art included patterned gel cushions. Patterned gel cushions are gels with patterns, cuts or texture having geometric shapes and dimensions insufficient to produce elastomeric members that have compression instability. The pattern merely accommodates changing shape of the gel as it compresses. Thus, although those prior art devices at first glance may have some physical resemblance to the invention, they fail to include either the structure or functionality that is the subject of the present invention.

Summary of Invention

[0009] It is an object of some embodiments of the invention to provide cushions and cushion elements with elastomeric members exhibiting compression instability and which do not have intersecting or joined walls, referred to herein as non-intersecting-columnar members to distinguish them from intersecting-columnar cushion members. Further objects, features and advantages of the invention will become apparent to persons of ordinary skill in the art on reading this document.

Brief Description of Drawings

[0010] Figure 1 depicts an example of a cushion with non-intersecting-columnar elastomeric members exhibiting compression instability.

Detailed Description

[0011] As an introductory matter, the reader may find it helpful to be informed of materials which may be used to fabricate the structures of the invention. Any elastomeric material which tends to compress under a load can be used as a material to make the cushions and cushion elements of the invention. Such materials include natural and synthetic rubbers, foams, thermoplastic elastomers, polyurethane elastomers, silicone elastomers, polyvinyl chloride (PVC) elastomers, olefinic elastomers, polyamide elastomers, and the like. Superior performance has been achieved by the inventor when gelatinous elastomers which are substantially non-flowable at room temperature (below 130 degrees Fahrenheit) are used. Such gels are disclosed in U.S. Patent No. 5,994,450 which is hereby incorporated by reference. Alternative gels, which the inventor considers inferior due to their high tack, excessive oil bleed and low durability, have been patented in the name of John Y. Chen of Applied Elastomerics, Inc. Examples of such gels may be found in U.S. Patent Nos. 6,161,555; 6,148,830; 6,117,176; 6,050,871; 6,033,283; 5,962,572; 5,938,499; 5,884,639; 5,868,597; 5,760,117; 5,655,947; 5,633,286; 5,624,294; 5,508,334; 5,475,890; 5,336,708; 5,334,222; 5,324,222; 5,262,468; 5,260,371; 5,239,723; 5,153,254; 4,618,213; and 4,369,284. However, some of those later Chen patents appear to be anticipated by U.S. Patent No. 5,994,450, and some of the earlier Chen patents appear to be anticipated by U.S. Patent No. 3,827,999 by inventor Ronald Crossland. Another gel that is available is called "J-SOFT", a pelleted injection molding material offered by ATP, a division of Newgrange Company in Rhode Island.

[0012] As a general matter, cushions and cushioning elements of the invention may be fabricated using an A-B-A triblock copolymer pasticized with a plasticizing agent such as an oil. Some embodiments of the A-B-A triblock copolymer will have glassy end blocks and elastomer mid blocks. For example, SEEPS, SEBS, and SEPS are such

polymers, and mineral oil is a suitable plasticizing agent. Additives may be included such as anti-oxidants, colorants, and microspheres to reduce weight and/or tackiness. It is expected that the ratio of oil to polymer in the gel will be in the range of 1.0:1.0 to 8.5:1.0, although it could be outside of that range. In most gel structures of the invention, the ratio of oil to polymer will be 1.5:1.0 to 5.5:1.0.

[0013] Gelatinous elastomers are a good choice as a material for making cushions and cushioning elements of the invention because of their ability to be subject to repeated or sustained loads without a permanent change in material dimensions or properties and due to their ability to reshape hydrostatically under load.

[0014] Gels used to make cushions of the invention may be pre-fabricated prior to making the cushion in question, or they can be made at the time of cushion manufacture. The gels may be made from any appropriate technique including melt blending, solvent blending, and mixing using a single screw, twin screw or multiple screw mixing device, or as part of the injection molding or extrusion process.

[0015] Referring to Figure 1, a cushion of the invention is depicted as a shoe insole by way of example and for purposes of discussion. In practice, the invented structures may be used in a variety of fields and for a variety of applications without bounds. The insole depicts non-intersecting-columnar elastomeric members exhibiting compression instability in a variety of configurations. The insole may have a base of an appropriate material such as fabric or gel. A cover for the insole may also be provided.

[0016] In Figure 1, member 1 is a curvy wall of gel which supports a certain amount of load by compressing, during which the wall thickness increases by the well-known principle of Poisson"s Effect. However, if the pressure exceeds the pre-engineered stability limit of that non-intersecting-columnar elastomeric member 1, that wall will fold or bend at one or more points along its height in order to relieve peak pressure. Alternative walls could be straight or have other shapes. Engineering of planned instability into a gel column in a cushion utilizes the inventive principles. Such engineering activity may take into account several factors, including durometer of the gel, thickness and cross-sectional shape of the column wall, height of the column wall, maximum load exerted by the cushioned object, and characteristics and locations of nearby non-intersecting-columnar elastomeric members.

[0017] Also in Figure 1, member 2 is a non-intersecting-columnar elastomeric member configured as a vertical post of gel having an oval cross section. The post 2 will also have engineered instability in its design. Each post is considered to have a longitudinal axis along the direction from which it is expected to receive a compressive force, and the posts are intended to be designed so that such compressive forces cause unstable buckling.

[0018] Member 3 of Figure 1 depicts a non-intersecting-columnar elastomeric member configured as a vertical post of gel having a square cross section, again exhibiting compression instability.

[0019] Member 4 of Figure 1 depicts a non-intersecting-columnar elastomeric member configured as a straight wall running the width of the depicted insole. Other dimensions and orientations of the member are possible. Height of the wall, width of the wall, and durometer of the gel are chosen to achieve compression instability.

[0020] Member 5 of Figure 1 depicts an arch support configured from non-intersecting-columnar elastomeric members joined at one of their ends. Principles of the invention can be upheld as long as enclosed hollow columns with intersecting walls and/or walls shared with other enclosed hollow columns are not provided. In the context of the foregoing sentence, enclosed shall mean that in any direction transverse to the anticipated principle cushioning direction, the elastomeric material seals the hollow column. Enclosed does not necessarily mean that the top or bottom of the hollow column is sealed by the elastomeric material.

[0021] Non-intersecting-columnar elastomeric members may be of different heights at different locations on a cushion as desired to accommodate the cushioned object, such as a foot arch. Using such geometric variation, cushions can be designed to suit almost any irregular shape.

[0022] Non-intersecting-columnar elastomeric members may include hollow posts or columns, as long as they maintain the non-intersecting and compression instability principles of the invention and their walls do not share walls with other fully enclosed hollow columns. Hollow posts or columns may be open or closed at their top ends or anywhere within their height as desired.

[0023] Compression instability of non-intersecting-columnar gel members may be engineered taking into account member geometry and dimensions and gel material properties. In addition to compression instability of non-intersecting-columnar elastomeric members, other functions which may be desired to be engineered into cushions of the invention include rebound rate of the non-intersecting-columnar members, shock absorption, and vibration attenuation. Compression instability may be engineered to anticipate loading of force onto the cushion from a pre-determined direction or directions.

[0024] Shape of the non-intersecting-columnar members can be any shape as desired for the particular cushioning application. Important factors include height of the column, cross sectional shape of the column, durometer of the material, and desired instability threshold.

[0025] Avoiding intersecting walls in the non-intersecting-columnar members of the invention permits fabrication of cushions and cushion elements of the invention by injection molding without creating knit lines and their concomitant weaknesses. Molds for making the invented structure tend to be simple and inexpensive to produce. Weight of the finished cushion or cushioning element is reduced compared to other gel or elastomer cushion structures due to less total wall length of the columns. It is also quite easy within the invention to produce a cushion or cushion element that has a varied or irregular geometric appearance. As desired, all or just a subset of the cushioning members may be non-intersecting, and all or just a subset of the elastomeric cushioning members may exhibit compression instability.

[0026] The cushioned object need not be in direct physical contact with the non-intersecting gel column members, and may be separated by a cover or other material.

[0027] The invention is applicable to any cushioning, pressure relieving, shear relieving, shock absorbing, vibration attenuating, or energy returning cushioning application, regardless of size of the cushioning elements. The cushions and cushion elements have application in a variety of fields, including foot care products, seat cushions, mattresses and mattress overlays for consumer and medical applications, carry straps, sports injury prevention, orthopedics, vibration dampeners for electrical and electronic equipment, shock absorbers and others.

[0028] While the present invention has been described and illustrated in conjunction with a number of specific embodiments, those skilled in the art will appreciate that variations and modifications may be made without departing from the principles of the invention as herein illustrated, as described and claimed. The present invention may be embodied in other specific forms without departing from its spirit or essential characteristics. The described embodiments are considered in all respects to be illustrative and not restrictive. The scope of the invention is, therefore, indicated by the appended claims, rather than by the foregoing description. All changes which come within the meaning and range of equivalence of the claims are to be embraced within their scope.